

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
28 February 2002 (28.02.2002)

PCT

(10) International Publication Number
WO 02/17322 A2

(51) International Patent Classification⁷: **G11C**

(21) International Application Number: PCT/NO01/00347

(22) International Filing Date: 24 August 2001 (24.08.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2000 4237 24 August 2000 (24.08.2000) NO

(71) Applicant (for all designated States except US): **THIN FILM ELECTRONICS ASA** [NO/NO]; P.O. Box 1872 Vik, N-0124 Oslo (NO).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **THOMPSON, Michael** [US/US]; Cornell University, Bard hall 329,

Ithaca, NY 14853-1501 (US). **WOMACK, Richard** [US/US]; High Density Circuits Inc., 9521 Academy Hills Dr. NE, Albuquerque, NM 87111-1305 (US).

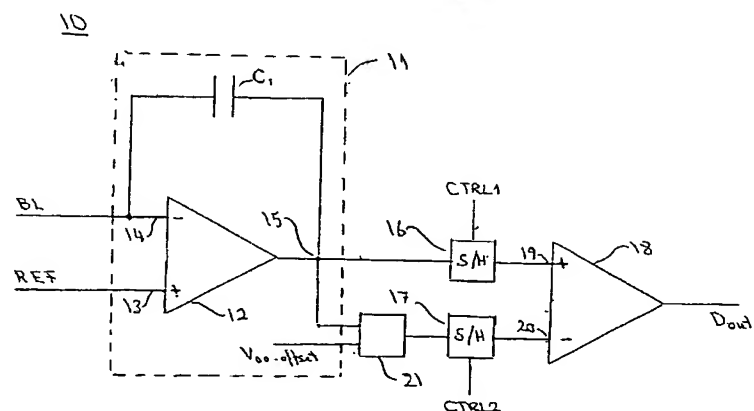
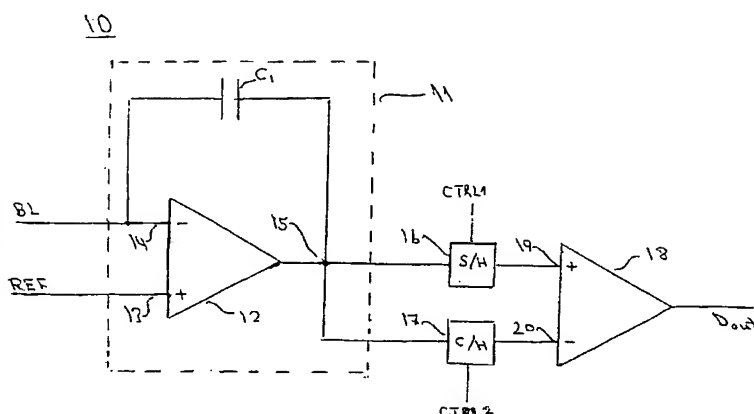
(74) Agent: **LEISTAD, Geirr, I.**; Thin Film Electronics ASA, P.O. Box 1872 Vik, N-0124 Oslo (NO).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF,

[Continued on next page]

(54) Title: SENSING DEVICE FOR A PASSIVE MATRIX MEMORY AND A READ METHOD FOR USE THEREWITH



(57) Abstract: A sensing device (10) for reading data stored in a passive matrix memory comprising memory cells in the form of ferroelectric capacitors, comprises an integrator circuit (11) for sensing the current response and means (16, 17, 18) for storing and comparing two consecutive read values, one of which is a reference value. In a read method for use with the sensing device a bit line is connected to the sensing device for sensing a charge flowing therebetween and a memory cell at the crossing of the former and an activated word line, whereafter two consecutive reads of the memory cell are performed an integrated over predetermined time periods in order to generate first and second read values which are compared for determining a logical value dependent on the sensed charge.

WO 02/17322 A2



CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *without international search report and to be republished upon receipt of that report*

Sensing device for a passive matrix memory and a read method for use therewith

The invention concerns a sensing device for reading data stored in a passive matrix memory comprising memory cells in the form of ferroelectric capacitors, wherein said sensing device senses a current response
5 corresponding to the data, typically a binary one or a binary zero, and performs an integration of two read values.

The invention also concerns a read method for use with the sensing device according to the invention, wherein the sensing device are used for reading
10 data stored in a passive matrix memory with word and bit lines and comprising memory cells in the form of ferroelectric capacitors at crossings between the word and bit lines, wherein the sensing device senses a current response corresponding to the data stored in a memory cell, typically at
15 binary one or a binary zero, and performs an integration of read values, wherein the read method comprises controlling the electric potentials on all word and bit lines in time latching word line potentials to potentials selected among predetermined word line potentials and either latching bit lines to potentials selected among predetermined bit line potentials, wherein bit lines
20 in a read cycle are connected to the sensing device for sensing a charge flowing between a selected bit line and a memory cell at the crossing of the former and a word line activated by being latched to a selected potential for initializing the read cycle.

Ferroelectric matrix memories can be divided into two types, one type containing active elements linked to the memory cells, and one type without
25 active elements. In the following focus is directed only towards passive matrix memories without active elements, such as diodes or transistors that are locally associated to the memory cells.

A ferroelectric matrix memory can have memory cells in the form of ferroelectric capacitors without active access elements such as an access
30 transistor and comprises a thin ferroelectric material with a set of parallel conducting electrodes ("word lines") deposited on one side and an essentially orthogonal set of conducting electrodes ("bit lines") deposited on the other side. This configuration is referred to as a "passive matrix memory". In the passive matrix memory, the individual memory cells are formed at the
35 crossing-points of the opposing electrodes creating a memory matrix

comprising memory cells that can be individually accessed electrically by selective excitation of the appropriate electrodes from the edge of the matrix.

To write to a memory cell, a positive or negative voltage is applied to the electrodes, causing the ferroelectric material to move along its hysteresis
5 curve to a stable state corresponding to the written datum, a binary one or a binary zero. To determine the data thus stored in a ferroelectric capacitor, a voltage (typically in the form of a voltage pulse) is applied across the plates of the capacitor, whereby a current response is sensed by means of a sensing device, typically a sense amplifier. The sensing device is typically connected
10 to a respective bit line, directly or via a multiplexer or gate.

One of the difficulties during sensing is to establish a reference being able to discriminate between a binary zero and a binary one. One solution is to introduce a reference voltage to the sense amplifier, which is described for instance in US-A-5 905 671. Any observed signal above the reference is
15 taken as one of two logic states, while any signal below the reference is taken as the other logic state.

However, there are several limits and drawbacks with the described reference method and similar direct reference methods, which will be further described below.

20 Assuming stable and predictable conditions, a parasitic contribution may in principle be removed by subtracting a fixed amount of charge from that recorded by the sense amplifier during the reading cycle. In many instances, however, the magnitude and variability of the parasitic contribution makes this inappropriate. Thus, in addition to the manufacturing tolerances for the
25 device, the fatigue and imprint history may vary within wide limits between different cells in the same memory device and even on the same bit line, and the parasitic current may depend strongly upon the device temperature at the time of readout. In addition, the parasitic current associated with a given non-addressed cell on the active bit line may depend on the actual logic state
30 of this cell. In that case the cumulative parasitic current from all non-addressed cells on the active bit line depend on the set of data stored in those cells, which then must define prediction. Thus, there are many drawbacks using a direct reference.

Reference levels can also be obtained from neighbouring cells to deal with the problems indicated above. The neighbouring cells are believed to have the same conditions as the read cells. However, this is not always true, giving rise to problems.

- 5 Another implementation is to have a single current integrator providing the signal level corresponding to a known polarization change. A non-unity gain amplifier then distributes this potential as the reference level to a number of sense amplifiers.

- 10 All of the above-described methods of obtaining a reference share the problem of non-predictable conditions, whereby there still is a need of another solution for obtaining a true reference.

- 15 Hence it is a primary object of the invention to improve referencing of the sensing device, whereby the sensing device becomes resistant to noise and other interfering background signals. Another object of the invention is to provide a sense amplifier, which is not influenced by cumulative signals from non-addressed cells during reading of stored data, obtained i.e. in a so-called "partial word read". Finally, there is also an object of the invention to provide a read method for use with a sensing device of this kind.

- 20 The above-mentioned objects as well as other features and advantages are realized according to the present invention with a sensing device, which is characterized in that the sensing device comprises an integrator circuit for sensing the current response and means for storing and comparing two consecutive read values, one of which is a reference value.

- 25 In an advantageous embodiment of the sensing device according to the invention the integrator circuit comprises an operational amplifier and a capacitor connected between an inverting input of the operational amplifier and the output thereof. Preferably the integrator circuit then comprises a switch connected in parallel over the capacitor.

- 30 In an advantageous embodiment of the sensing device according to the invention the means for two consecutive reads comprises a first sample/hold circuit for sampling/storing a first read value, a second sample/hold circuit for sampling/storing a second read value, and a comparator circuit connected to the outputs of the sample/hold circuits for determining the state of an addressed memory cell.

Preferably the sample/hold circuits then can comprise capacitors and preferably can the comparator circuit be an operational amplifier.

Finally, a correction circuit can be connected between the second sample/hold circuit and the output of the integrator circuit.

5 The above-mentioned objects as well as other features and advantages are also realized according to the present invention with a read method which is characterized by two consecutive reads of a memory cell, integrating each read over a predetermined time period respectively to generate a first and a second read value, storing said read values, comparing the stored read values,
10 and determining a logical value dependent on the sensed charge.

In an advantageous embodiment of the read method according to the invention a time delay is introduced between two consecutive reads in a read cycle.

15 The invention will now be explained in more detail in conjunction with the appended drawing figures, wherein

fig. 1 shows the principle of dual slope integration as used in the invention,

fig. 2 the principle shown in fig. 1 in more detail,

fig. 3a a generalized circuit diagram of a sensing device according to the invention,

20 fig. 3b a variant circuit diagram of the sensing device in fig. 3a, and

fig. 4 a circuit diagram of a sensing device with dual slope integration according to a preferred embodiment of the invention.

The invention implements a dual read which can be performed according to two principal schemes, termed (I) and (II) below.

25 (I) Dual read by means of a "single read" comprising a dual sensing operation, whereby word line WL is pulsed high once after a long bit line settling time followed by two successive reads (integrations).

(II) Dual read whereby a second read is subtracted from a first read to determine a stored value. The advantage is that common offsets/mismatches are removed. The
30 word line WL is pulsed twice and sensing is performed during each word line WL being high.

The dual read method has the purpose of reducing the effect of the background current and also provide a self-reference on a particular bit line. In fig. 1 an integrated charge versus time graph is shown. The difference in magnitude of the background currents and the charge emanating from the active cell is curve (i) as illustrated. Curve (ii) represents a logical "1" stored in the cell and curve (iii) a logical "0". In this particular example a first read is performed between a first time point t_1 and a second time point t_2 and a second read between the second time point t_2 and a third time point t_3 .

A more detailed relationship between the sensed charges can be seen in Fig. 2. Assuming an active cell containing a "1" during the first read between the first time point t_1 and the second time point t_2 , first a read value $\Delta Q_1(\text{"1"}) = Q_4 - Q_1$ is sensed, and during the second read between the second time point t_2 and the third time point t_3 , a second read value $\Delta Q_2(\text{"1"}) = Q_5 - Q_4$ is sensed in a similar manner. The first read value is stored in a first sample/hold circuit and the second read in a second sample/hold circuit, as will be mentioned below. These can for instance comprise a capacitor as charge storage element. Other charge storage elements are of course also possible. This will be described below in connection with a discussion of embodiments of the sensing device according to the invention.

In the same way for an active cell containing a "0" one gets $\Delta Q_1(\text{"0"}) = Q_2 - Q_1$ and $\Delta Q_2(\text{"0"}) = Q_3 - Q_2$. But ΔQ_1 will in this example be larger than ΔQ_2 for both a "1" and "0". Therefore, one has to introduce a threshold level in order to distinguish a "0" from a "1".

Fig. 3 shows schematically the principal functional components of a sensing device 10 according to the invention, providing dual read covering both the above-described principal sensing schemes (I) and (II). First a read, typically an integration of the current I_{BL} on the bit line BL is performed by an integrator circuit 11 (inside the dashed line) comprising an integrating amplifier 12 with a non-inverting input 13 and an inverting input 14, and a feedback capacitor C1 connected in parallel between the non-inverting input 14 and the output of the amplifier 12. First and second read values output from the integrating circuit 11 are stored in first and second sample/hold circuits 16;17 respectively. Each sample/hold circuit 16;17 has an input for a control signal CTRL1; CTRL2. A comparator, preferably an operational

amplifier 18 is connected with sample/hold circuit 16 via its non-inverting input 19 and via its inverting input 20 with sample/hold circuit 17. The comparator compares two stored read values sensed in the dual read and generates the comparison as a data output signal on its output D_{out} .

- 5 If a hypothetical value, herein denoted $V_{00-offset}$ is introduced as the threshold level, one obtains the following conditions for the output.

$\Delta Q_1 - \Delta Q_2 > V_{00-offset}$, which is interpreted as a "1", and

$\Delta Q_1 - \Delta Q_2 < V_{00-offset}$, which is interpreted as a "0".

- 10 In this way, the error introduced by the background current, the offset and process variation of the transistors in the integrating amplifier will manifest itself as a constant value in the $\Delta Q_1 - \Delta Q_2$ calculation. This error can be eliminated by adjusting the hypothetical value $V_{00-offset}$ in a correction circuit. Fig. 3b shows a variant embodiment of the device in fig. 3a, but with the correction circuit 21 connected between the second sample/hold circuit 17
15 and the output 15 of the integrator circuit 11.

- Now fig. 4 illustrating a preferred embodiment of the invention shall be discussed. In this embodiment the sensing device 10 comprises an integrator circuit 11 (inside the dashed line) with an operational amplifier 12 having a non-inverting input 13, an inverting input 14, an output 15, and a feedback capacitor C1 connected between the output 15 and inverting input 14 of the operational (integrating) amplifier 12. In parallel to the feedback capacitor C1 there is provided a first switch SW1, which can be closed before sensing starts. The first switch SW1 is able to switch between at least two states, an open state and a closed state, of which the open state is shown.

- 25 The feedback capacitor C1 is initially shorted allowing the bit line BL to be charged to the non-inverting input's 13 potential through the output stage of operational amplifier 12. The bit line potential V_{BL} will differ from a switching level V_s by the input offset V_{offset} of the operational amplifier 12. However, as long as the magnitude of the input offset voltage V_{offset} is small
30 compared to the total switching potential V_s of a memory cell, it can be neglected.

When the first switch SW1 opens, a small amount of charge will be injected onto the bit line BL from the capacitor C1 and must be cancelled in a

comparator 18, which is connected to the output 15 of the integrator circuit 11. Subsequently current flowing to the bit line BL must also flow through the feedback capacitor C1, resulting in a potential shift of Q/C , where Q is the charge from the active memory cell to be read and C is the feedback capacitance. Since the potential on the bit line BL remains nearly constant, determined by the open loop gain of the operational amplifier 12, the total capacitance C_{BL} of the bit line BL does not affect the observed signal level. The magnitude of the signal may also be established by judicious choice of the value of the feedback capacitor C1.

The output 15 of the integrator circuit 11 is AC-coupled to the comparator 18 via a capacitor C2, corresponding to the sample/hold circuit 16. To provide an absolute reference a switch SW2 is connected between ground and the output side of capacitor C2. In order to cancel out a transient from switch SW1, switch SW2 opens after the sensing by the integrator circuit 11 starts.

It is possible to develop a self-referencing algorithm based on sequential integration of a single bit line BL. In this two-stage sensing, the integrator circuit 11 provides a self-reference to cancel out leakage currents and other common mode noise on the bit line BL. As illustrated in figure 4, a third switch SW3 connected between the output 15 via the second capacitor C2 which operates as the sample/hold circuit 16 in fig. 3a, and the non-inverting input of comparator 18, and a fourth switch SW4 connected between ground and the inverting input of comparator 18 are provided for this purpose. The upper side of the fourth switch SW4 is via a third capacitor C3 which operates as sample/hold circuit 17 in fig. 3a connected to the output 15.

During reset of the integrator circuit 11 comprising the operational amplifier 12, the first switch SW1, the second switch SW2, and the third and fourth switches SW3 and SW4 are closed. The first switch SW1 opens to start integration, followed by SW2 to latch the offset error introduced by opening the first switch SW1. After the first time period, the third switch SW3 is opened, isolating the first time period integration value (cf. the period between time points t_2 and t_1 in fig. 2) on the second capacitor C2. The fourth switch SW4 is opened (possibly before the third switch SW3 opens) to begin integration during the second time period. Any leakage currents will appear as common mode signals to the inputs of the comparator 18 and thus cancel out, leaving only the charge differential arising from a polarization change. The periods of integration for the second and third capacitors C2 and

C3 may be adjusted, as necessary, to establish appropriate margins for the comparator 18.

The addressing scheme for performing a read according to the invention using the inventive sensing device, shall now be described in some detail.

5 During a read cycle the electric potentials on all word and bit lines are controlled in time according to a protocol or timing sequence whereby word line potentials are latched in a predetermined sequence to potentials selected among predetermined word line potentials, while bit lines are either latched in a predetermined sequence to potentials selected among predetermined bit
10 line potentials or said bit lines are during a certain period of the timing sequence connected to circuitry that senses the charges flowing between the bit line(s) and the cells connecting to said bit line(s), two consecutive reads of said addressed cells are performed during the read cycle. The two read values obtained are stored in the sample/hold circuits and finally compared in
15 the comparator of the sensing device.

Between said consecutive reads there may be a time or dwell delay. The result of an integration of the current sensed by means of the sensing device performed during the first of the two reads in a read cycle to determine the logic value of an addressed cell (to determine whether the cell contains a
20 logic "0" or a logic "1"), is stored in the first sample/hold circuit. The read is always a destructive read ending up in a "0" and the memory cell must therefore be restored to its initial state (since a "1" or a "0" always ends up in a "0" because of the destructive read). The dwell delay is inserted to allow the material in the memory cell to return to a relaxed condition. The second
25 read is executed using an identical pulsing and sensing protocol as the one used during the first read. The result of the second read is evaluated in the same way as the first read and stored in the second sample/hold circuit. The values stored in the first and second sample/hold circuits are then transferred to the comparator for determining the state of the addressed cell. Since the
30 consecutive reads expose the bit lines to the same conditions in both cases, the offset currents are almost cancelled. The use of the same sensing device, typically the same integrating amplifier similarly, eliminates the concern over matching of circuit parameters and component values.

The dual slope integration particularly addresses a wide number of potential
35 problems in ferroelectric memories with a polymer memory material. First,

the comparison can be established with a margin close to zero. Consequently, in a fatigued memory cell where the charge is released at a lower level and occurs slower, the sensing device will still distinguish the state since the total charge released in a first time period is greater than that released in a
5 subsequent (equivalent) time period. There is no need for a-priori knowledge of the level of fatigue to properly sense the memory cell value. Similarly, following imprint, the absolute magnitude of the charge released in any given first time period is reduced due to the shift in the coercive field, but the relative value is still ordered. Again, the state of the memory cell can be
10 determined with the dual slope integration without knowledge of the imprint magnitude.

In an alternative embodiment of the invention it is possible to use a pre-read cycle immediately preceding the readout cycle and differing from the latter in only one respect, namely that the active word line is not shifted at all. The
15 sensing device is then activated in precisely the same time slot relative to the bit line voltage shifts as is the case in the subsequent read cycle. Thus, the cumulative charge detected during the pre-read cycle shall correspond very closely to the parasitic current contributions captured during the read cycle, including contributions from the active cell. The detected charge from the
20 pre-read cycle is stored and subtracted from that recorded during the read cycle, yielding the desired net charge from the switching or non-switching transient in the active memory cell.

PATENT CLAIMS

1. A sensing device (10) for reading data stored in a passive matrix memory comprising memory cells in the form of ferroelectric capacitors, wherein said sensing device (10) senses a current response corresponding to
5 the data, typically a binary one or a binary zero, and performs an integration of two read values,
characterized in that the sensing device (10) comprises an integrator circuit (11) for sensing the current response and means (16,17,18) for storing and comparing two consecutive read values, one of which is a reference value.
- 10 2. A sensing device (10) according to claim 1,
characterized in that the integrator circuit (1) comprises an operational amplifier (12) and a capacitor (C1) connected between an inverting input (14) of the operational amplifier (12) and the output (15) thereof.
3. A sensing device (10) according to claim 2,
15 characterized in that the integrator circuit comprises a switch (SW1) connected in parallel over the capacitor (C1).
4. A sensing device (10) according to claim 1,
characterized in that the means (16,17,18) for two consecutive reads comprises a first sample/hold circuit (16) for sampling/storing a first read
20 value, a second sample/hold circuit (17) for sampling/storing a second read value, and a comparator circuit (18) connected to the outputs of the sample/hold circuits (16;17) for determining the state of an addressed memory cell.
5. A sensing device (10) according to claim 4,
25 characterized in that the sample/hold circuits (16;17) comprise capacitors (C₂;C₃).
6. A sensing device (10) according to claim 4,
characterized in that the comparator circuit (18) is an operational amplifier.
7. A sensing device (10) according to claim 4
30 characterized in that a correction circuit (21) is connected between the second sample/hold circuit (17) and the output (15) of the integrator circuit (11).

8. A read method for use with the sensing device according to claim 1, wherein the sensing device are used for reading data stored in a passive matrix memory with word and bit lines and comprising memory cells in the form of ferroelectric capacitors at crossings between the word and bit lines, wherein the sensing device senses a current response corresponding to the data stored in a memory cell, typically at binary one or a binary zero, and performs an integration of read values, wherein the read method comprises controlling the electric potentials on all word and bit lines in time latching word line potentials to potentials selected among predetermined word line potentials and either latching bit lines to potentials selected among predetermined bit line potentials, wherein bit lines in a read cycle are connected to the sensing device for sensing a charge flowing between a selected bit line and a memory cell at the crossing of the former and a word line activated by being latched to a selected potential for initializing the read cycle, characterized by performing two consecutive reads of a memory cell, integrating each read over a predetermined time period respectively to generate a first and a second read value, storing said read values, comparing the stored read values, and determining a logical value dependent on the sensed charge.
9. A read method according to claim 8, characterized by introducing a time delay between two consecutive reads in a read cycle.

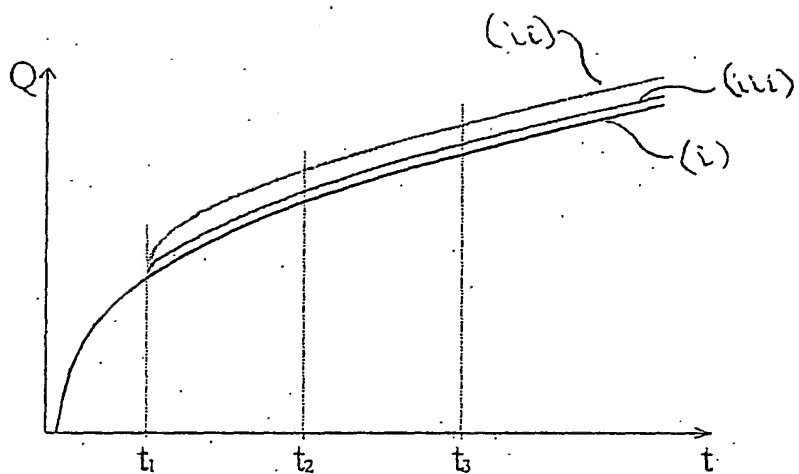


Fig. 1

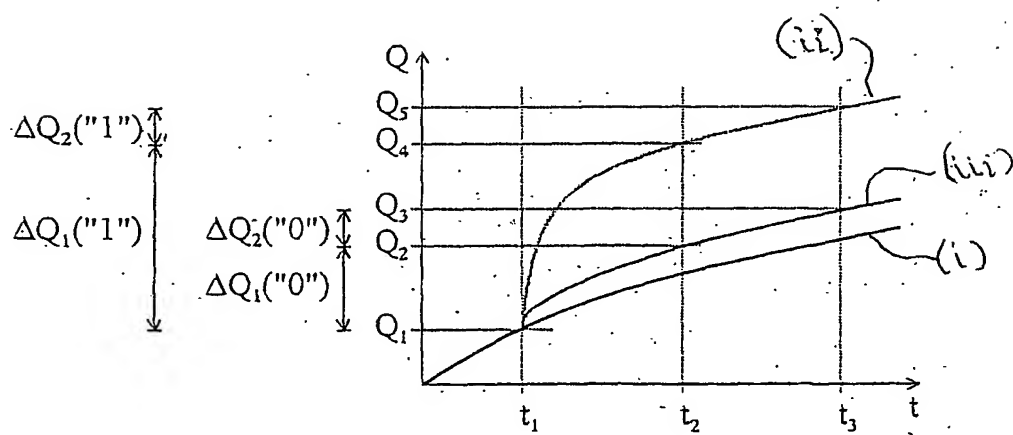


Fig. 2

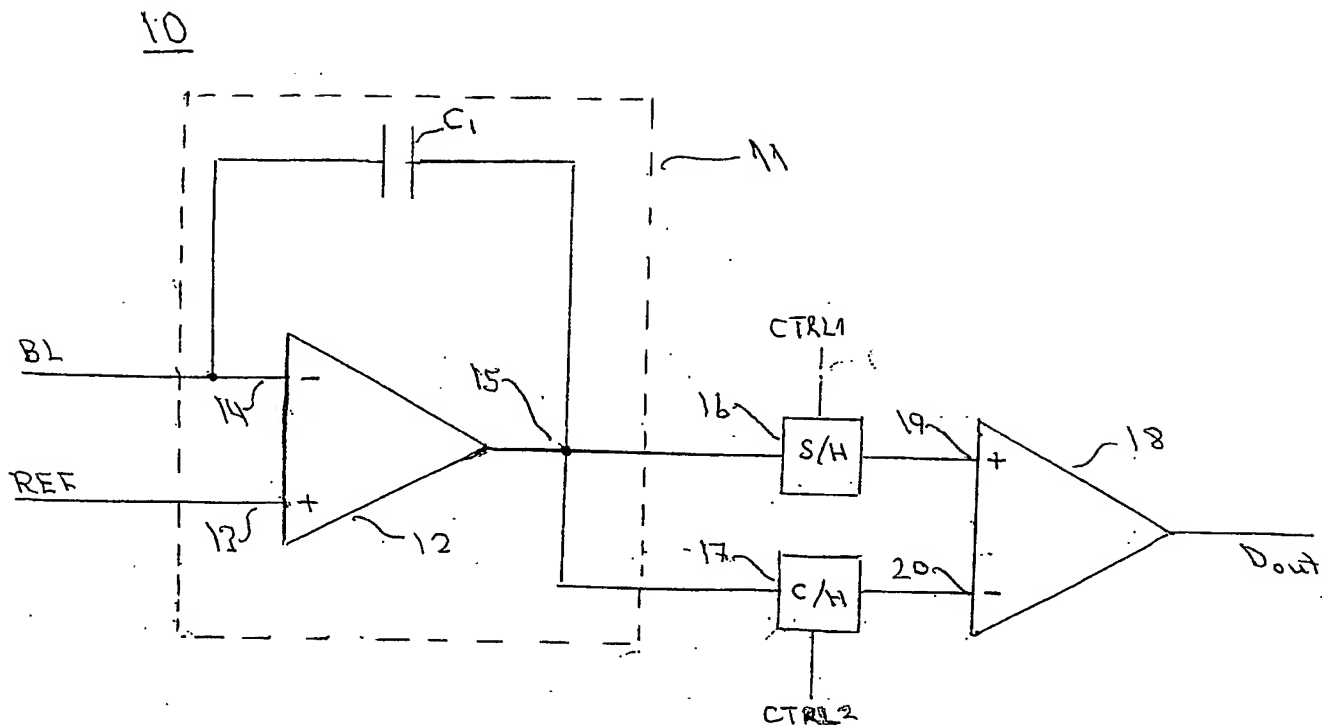


Fig. 3a

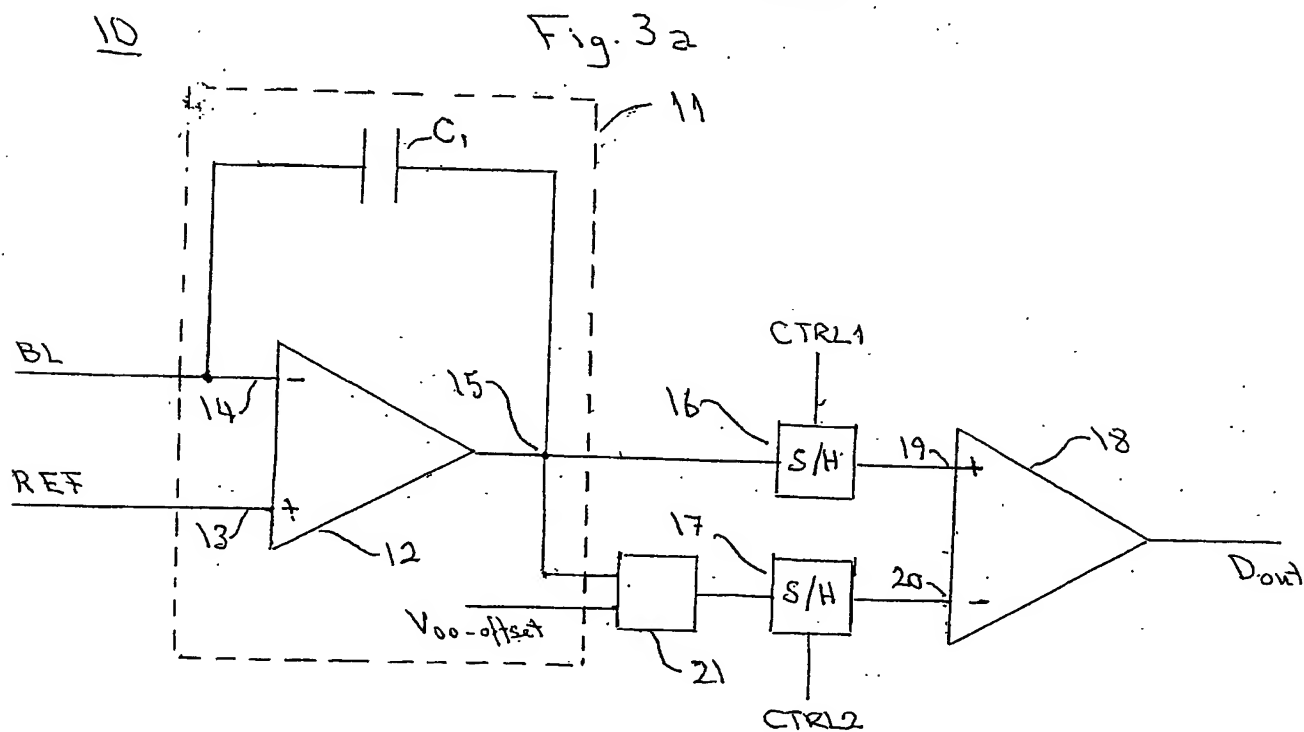


Fig. 3b

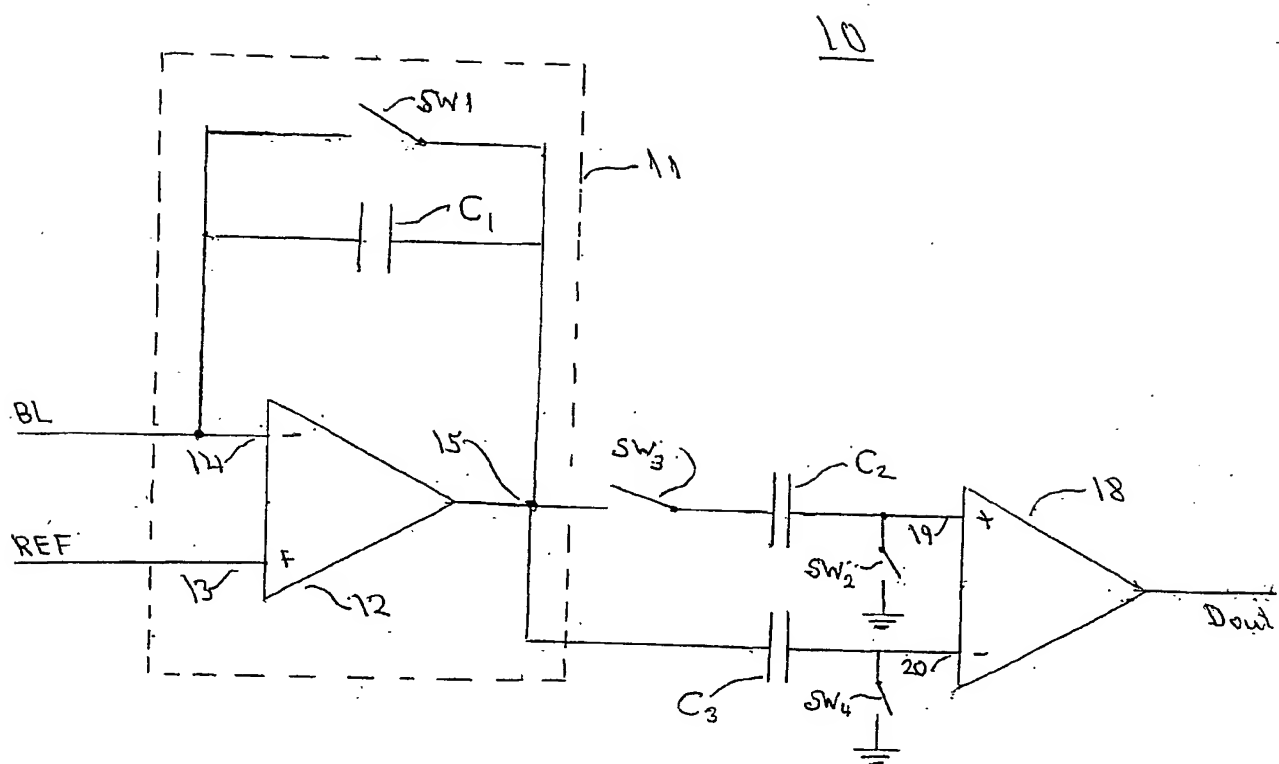


Fig. 4

PATENT COOPERATION TREATY

10/088096

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

LEISTAD, Geirr, I.
Thin Film Electronics ASA
P.O. Box 1872 Vika
N-0124 Oslo
NORVÈGE

Date of mailing (day/month/year) 30 May 2002 (30.05.02)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference Opti53aPCT	
International application No. PCT/NO01/00347	International filing date (day/month/year) 24 August 2001 (24.08.01)
International publication date (day/month/year) 28 February 2002 (28.02.02)	Priority date (day/month/year) 24 August 2000 (24.08.00)
Applicant THIN FILM ELECTRONICS ASA et al	

- The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
- This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
- An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
- The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
24 Augu 2000 (24.08.00)	2000 4237	NO	25 Apri 2002 (25.04.02)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Hans LEISE

Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

13/19/200

Applicant's or agent's file reference Opti53aPCT	<div style="display: flex; justify-content: space-between;"> <div>FOR FURTHER ACTION</div> <div>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</div> </div>
International application No. PCT/NO 01/00347	<div style="display: flex; justify-content: space-between;"> <div>International filing date (<i>day/month/year</i>) 24 August 2001</div> <div>(Earliest) Priority Date (<i>day/month/year</i>) 24 August 2000</div> </div>
Applicant THIN FILM ELECTRONICS ASA ET AL.	

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (See Box II).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No. 3

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 01/00347

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G11C 11/22, G11C 7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G11C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP9091970 A ((OLYU) OLYMPUS OPTICAL CO LTD) 1997-04-04 (abstract), World Patents Index (online). London, U.K.: Derwent Publications, Ltd. (retrieved on 2002-02-08). Retrieved from: EPO WPI Database. DW9724, Accession No. 97-264691 --	1-9
A	US 5262982 A (M.P. BRASSINGTON ET AL.), 16 November 1993 (16.11.93), column 8, line 58 - column 10, line 49, figure 5 --	1-9
A	EP 0486901 A2 (NATIONAL SEMICONDUCTOR CORPORATION), 27 May 1992 (27.05.92), abstract --	1-9

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

8 February 2002

Date of mailing of the international search report

13-02-2002

Name and address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Bo Gustavsson/AE
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 01/00347

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5905671 A (ALAN DEVILBISS), 18 May 1999 (18.05.99), see the whole document, cited in the description -----	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/01/02

International application No.

PCT/NO 01/00347

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	5262982	A	16/11/93	JP	2892887 B	17/05/99
				JP	5198194 A	06/08/93
EP	0486901	A2	27/05/92	JP	3213356 B	02/10/01
				JP	4283489 A	08/10/92
				KR	205464 B	01/07/99
				US	5086412 A	04/02/92
US	5905671	A	18/05/99	EP	0888619 A	07/01/99
				JP	2000507025 T	06/06/00
				US	5721699 A	24/02/98
				WO	9735315 A	25/09/97